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SANITARY METHODS FOR SUPPLYING VESSELS WITH WATER FOR DRINKING AND CULINARY PURPOSES WHEN OBTAINED FROM SOURCES ASHORE.

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The following regulations, concerning water provided for drinking and culinary purposes on vessels, were approved by the Secretary of the Treasury and promulgated in Department Circular No. 234 of March 3, 1921:

> On and after April 15, 1921, any person, firm, or corporation operating vessels in interstate traffic or between foreign ports on or near the frontiers of the United States and adjacent ports in the United States will be required to furnish on such vessels water for drinking or culinary purposes under one of the following conditions:
>
> (*a*) If water for drinking or culinary purposes is not obtained ashore, it must be treated by an approved method.
>
> (*b*) If water for drinking or culinary purposes is obtained ashore, it must be from an approved source or treated by an approved method.
>
> On and after April 15, 1921, the piping system on all vessels must be so arranged that no connection can be made between the drinking-water system and any other water system aboard.
>
> On and after April 15, 1921, an approved sign, stating that the water is unfit to drink, must be properly placed at every tap or other outlet from which water of an unsatisfactory sanitary quality and safety may be obtained.

Since these regulations affect vessels operating in coastwise as well as in inland river and lake traffic, it is obvious that widely different conditions for supplying drinking water must be dealt with. Coastwise vessels must of necessity, on account of the salt in sea water, if for no other reason, obtain water from sources of supply ashore or distill sea water aboard. On the other hand, vessels plying on rivers and most of the inland lakes of this country have available "overboard" fresh water of varying degrees of safety and desirability for drinking purposes, ranging from the clear, sparkling, cold, and practically sterile water of certain areas of the Great Lakes to the relatively warm, muddy, and sewage-laden waters of the Ohio and Mississippi Rivers below some of the large cities of the Central West. In the past, water obtained directly from these sources and provided to passengers and crews for drinking purposes has been responsible for several typhoid fever outbreaks. Under the Federal regulations quoted in the beginning of this report, such practices are now unlawful.

To a shipping company, the selection of either or both of these two methods outlined in Treasury Department Circular No. 234 for providing drinking water on its vessels depends largely on the expense involved. This, in turn, is dependent on the waters in which the ships navigate, the type of vessels, and the service in which they are operated. Large storage tanks on a vessel may take up valuable space. The weight of the water carried in them must be given serious consideration. A water-treatment apparatus aboard, although eliminating the necessity for carrying large quantities of water and the inconveniences connected with obtaining drinking water from sources ashore, is an addition to the equipment not necessary for the navigation of the ship and is an apparatus which requires the careful attention of the engine-room crew.

The practicability of obtaining water for drinking and culinary purposes from certified sources ashore, for a bulk freighter operating on the Great Lakes and docking at piers and wharves along various canals and slips in the rivers or harbor at terminal ports, would be questionable, owing to the uncertainty of knowing in advance whether such water would be conveniently available at the piers at which the vessel would load or unload cargoes during a season. On the other hand, in Ohio and Mississippi River shipping, the city water at the larger ports of call is usually of very satisfactory sanitary quality and could be made conveniently available at the steamboat landing or wharf boat. In such cases, to obtain the drinking water for a large passenger vessel from these turbid and sewage-laden rivers and efficiently to treat same aboard would require careful operation of the treatment apparatus by trained men—a condition not likely to be provided for. Generally, it can be made convenient for all passenger vessels to obtain drinking water from certified sources ashore, because at the large terminal ports a safe water supply is usually available. Since the vessel docks at the same wharf or pier each trip, hydrants can be placed to facilitate prompt filling of the ship's water-storage tanks. However, for vessels not calling regularly at ports where drinking water of satisfactory sanitary quality or safety is available, some sort of treatment apparatus, such as a distiller, should be installed.

In order that all water provided on vessels for ablutionary purposes may be of the same sanitary quality and safety as that provided for drinking and culinary purposes, it may be more desirable and economical, on account of the great quantities of water required and the necessity for limiting the number of large water-storage tanks, to treat aboard water taken on en route than to carry aboard in tanks water obtained from sources ashore. This is particularly true in the case of vessels operating on the Great Lakes, for the physical quality of this water is such that it can be readily treated.

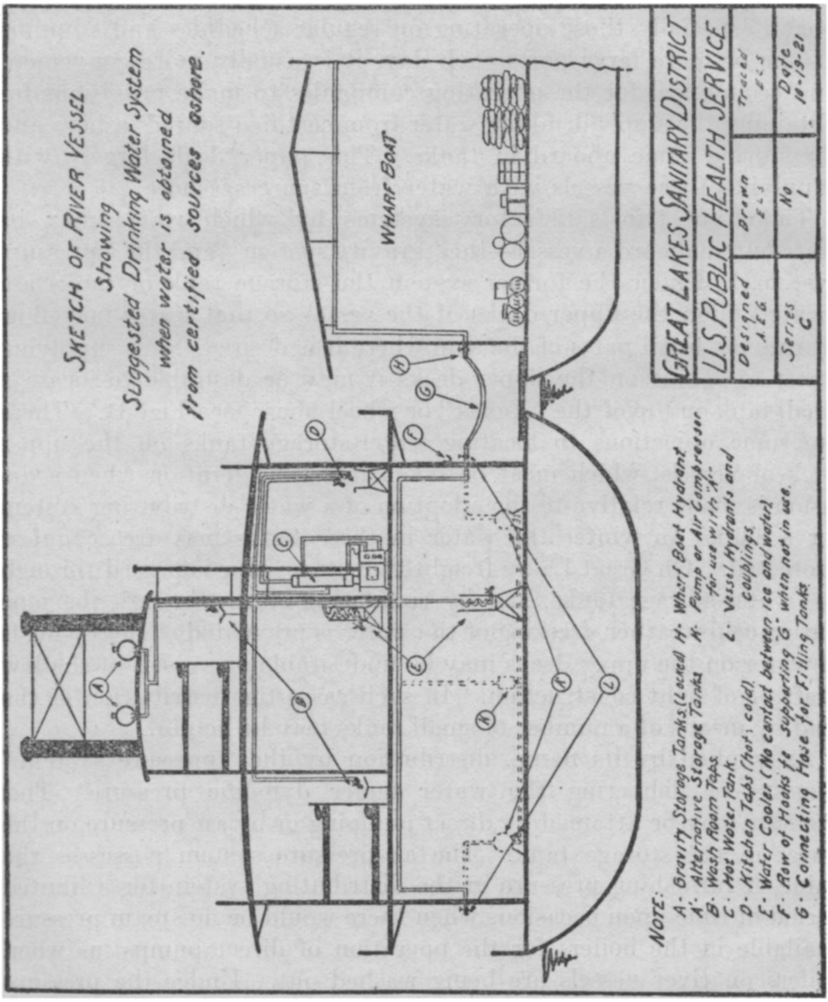
The majority of the companies owning the larger passenger vessels operating daily between terminal cities on these lakes (at which the public water supply is not only highly satisfactory but conveniently available at the piers) have elected to comply with the Federal regulations by disinfecting aboard all water used for the above purposes on their ships, obtaining the water to be thus treated either from sources ashore or directly overboard, or both. For smaller passenger boats, especially those operating on regular schedules and stopping at one or more large ports each day, it is usually more convenient and economical for the operating companies to make provisions for obtaining the ship's drinking water from certified sources ashore and for storing same aboard in tanks. This paper deals largely with supplying these vessels with water from sources ashore.

There are two satisfactory systems by which water may be distributed aboard a vessel—the "gravity system" and the "pressure system." Under the former system the storage tank or tanks are located upon the upper decks of the vessel, so that water may flow by gravity to all parts of the ship where it is desired. For supplying water to cabins on the upper decks it may be desirable to locate a small tank on top of the "Texas" or wheel house (see Fig. 1). There are some objections to locating water-storage tanks on the upper deck of vessels, which must be taken into consideration when a decision is made relative to the adoption of a water-distributing system for a ship. In winter the water in these tanks may freeze unless protected. On Great Lakes freighters a steam pipe is passed through the water-storage tanks, and by circulating steam through the pipe during cold weather, freezing of the water is prevented. Heavy loads of water on the upper decks may be undesirable on vessels of shallow draft or of light construction. In such cases the distribution of the load by means of a number of small tanks may be helpful.

As implied by its name, distribution by the "pressure system" consists of delivering the water under dynamic pressure. This pressure may be attained by direct pumping or by air pressure on the water in the storage tank. The air-pressure system possesses the value of furnishing pressure in the distributing system for a limited period of time upon occasions when there would be no steam pressure available in the boilers for the operation of direct pumps, as when boilers on river vessels are being washed out. Under the pressure system the storage tank may be located at any desirable place on the ship, preferably convenient to the engine room.

Water-storage tanks are frequently located in the hold of a vessel and there can be no objection to such a location, provided the tanks are clear from all bilge water and are provided with water-tight covers, which are kept locked. Tanks located in the hold are frequently inconvenient of access and consequently liable to neglect. For this reason it is highly desirable that tanks used for storing drinking and cooking water be located on deck. For their protection against damage by freight they should be inclosed.

Under no circumstances should drinking-water storage tanks be formed in part by the hull of the ship, because of the danger of contaminating the water stored therein in case a seam in the section of the hull forming part of this tank should be opened as a result of an accident. Forward and aft "peak" tanks have been and still are being used for storage of drinking water, but it is advisable that the use of such tanks for this purpose be prohibited. Down pipes from toilets or any other sewer lines or drains should not pass through the drinking-water tanks on a vessel.


SKETCH OF RIVER VESSEL
Showing
Suggested Drinking Water System
when water is obtained
from certified sources ashore.
WHARF BOAT
A
A'
B
C
D
E
F
G
H
K
L
NOTE:
A- Gravity Storage Tanks (Locked)
A'- Alternative Storage Tanks
B- Wash Room Taps
C- Hot Water Tank
D- Kitchen Taps (hot; cold)
E- Water Cooler (No contact between ice and water)
F- Row of Hooks fe Supporting 'G' when not in use.
G- Connecting Hose for Filling Tanks
H- Wharf Boat Hydrant
K- Pump or Air Compressor for use with 'A'
L- Vessel Hydrants and couplings.
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Date 10-19-21

Fig. 1.

Drinking-water storage tanks should always be identified as such by a sign, especially when similar tanks for other water are located on the vessel. It is also desirable that the covers to all tanks used for storage of water for drinking or culinary purposes should fit tightly and be kept locked at all times when not necessary to open same. The keys should be intrusted to the charge of the ship's officer responsible for the drinking-water supply.

In either the "gravity" or "pressure" installations a distributing system physically separate from all other piping systems aboard should be installed for delivering the drinking water throughout the vessel to places where it may be conveniently available, such as the galley quarters, public saloons, parlors, vestibules, all decks, engine room, fire hold, and, when so desired, the staterooms. Of course, if the running water in public lavatories and staterooms is supplied from the drinking-water tanks, the distributing system for this water may be the same as the drinking-water system. All the taps and hydrants aboard which are conveniently located so that they can be drawn upon for drinking and culinary purposes and which deliver water that is not of the regular certified drinking and culinary supply should be posted with appropriate signs stating that the water is unfit to drink.

The hot water used in the galley quarters and the chilled water at the drinking water coolers should be supplied through branch feed lines having no returns to the main distributing system; but it is usually advisable to have all other branch lines connected back to the main line. Coils of pipe forming a gridiron in the ship's refrigerator or passing through the ice box of a cooler are more satisfactory than the separate ice and water compartments in drinking water coolers. By such an installation former water storage barrels can be converted into water coolers at little expense (see Fig. 1).

It is necessary that the drinking water supplied to roustabouts and members of the crew be of the same sanitary quality as that provided for the public. In fact, from a public health standpoint, it may be even more important that these persons should be protected; for, on account of their ignorance, if they should become "typhoid carriers" they would be a relatively greater menace to the public health. "Old timers" who tell of having drunk "the good old river or lake water" all their lives without experiencing a day's sickness, and superstitious Negroes, who believe that a lump of coal in the bottom of a barrel will "remove all sickness from river water," should be reasoned with if possible and their stories discredited by the truth.

The present practice on Ohio and Mississippi River vessels of storing water in barrels, tanks, or other containers and drawing the water in smaller receptacles from these containers as needed, is very unsatisfactory and, where water to be used for drinking and culinary purposes is concerned, potentially dangerous, on account of the opportunities for contamination of the water through excessive handling. This "carry" system is very common on packet freight and passenger vessels operating on the Ohio and Mississippi Rivers.

Investigations of Ohio River Vessels.

During the summer of 1921 a special study was made of the sanitary quality of the water supplied for drinking and culinary purposes on passenger vessels operating on the Ohio River, especially out of Cincinnati.

Practically all of these vessels were supplied with drinking water from certified sources, such as the public supplies of Louisville, Ky., Cincinnati, Ohio, Evansville, Ind., Huntington, W. Va., and Pittsburgh, Pa. Water from these sources was delivered to the boats in many strange and different ways. On account of the fact that hydrants are not available at the landings in most of these cities, it was often necessary for the shipping companies to contract with some local truckman to deliver water to the landing in barrels. The contractor usually obtained this water from the nearest hydrant available above the public landing, and delivered it to the wharf boat in ordinary wooden kegs or barrels. In other cases, roustabouts were provided with wheelbarrows and sent to obtain water in kegs or barrels from the nearest hydrant available, or if wheelbarrows were not provided, the kegs or barrels were carried or rolled down the incline of the landing. The carrying of water in ordinary wooden buckets or galvanized-iron pails from the nearest hydrant to the storage tank or cooler aboard the vessel was another common practice. The cost of transporting water by these makeshift methods more than represents the interest charges upon a sum of money which would provide a satisfactory water-supply system upon the landing. As is usually the case in most shipping problems, the most satisfactory solution is the cheapest.

For general cooking, washing, and fire purposes, the water used aboard these vessels was invariably river water. Usually the hot water in the kitchen and pantry came direct from the boilers; whereas in some cases condensed steam was collected and used as far as possible, this supply being supplemented by the hot water from the boilers. Not infrequently the same container used for carrying river water from storage barrels to dry sinks in the staterooms for toilet purposes would be used for delivering drinking water from storage tanks to coolers and other smaller containers aboard the vessel. Sterilization of kegs, barrels, tanks, and pails in which drinking water was stored or transported was rarely done, the nearest attempt to it being a rinsing of the container. To one familiar with the insanitary conditions which exist, on the lower deck especially, of river packet vessels, the need of further description to point out the potential dangers connected with the supplying of drinking water to these vessels is quite unnecessary.

The following table, giving data relative to the results of bacteriological analyses of samples of drinking water from packet freight and passenger vessels operating on the Ohio River out of Cincinnati, gives a good idea of the sanitary quality of the drinking water which was served to the crews and the traveling public on these vessels during the summer of 1921.

Table I.

[Samples were collected and analyzed by the Cincinnati Board of Health.]

Fleet.[a]	Vessel.	Source of supply.	Storage aboard.	Number of samples.	Average bacteria per c. c. 37° C 24 hours.	B. coli determinations.							Use.
						Positive.			Negative.			Per cent positive 10 c. c.	
						c. c.			c. c.				
						10	1	0.1	10	1	0.1		
A	1	River; boilers	Wooden barrel	6	2,400	1	1	1	5	5	5	16.7	Washing dishes.
A	1	City supplies	Galvanized-iron barrel	9	2,100	1	1	1	8	8	8	11.1	Drinking.
A	1	do	do	6	2,500	4	4	4	2	2	2	66.7	Cooking.
A	2	do	do	8	6,000	4	4	4	4	4	4	50	Drinking.
A	2	do	do	12	5,200	7	7	7	5	5	5	58.3	Cooking.
A	3	River; boilers	Wooden barrels	3	5,600	3	3	3	0	0	0	100	Washing dishes.
A	3	City supplies	Galvanized-iron barrel	14	5,500	3	3	3	11	11	11	21.4	Drinking.
A	3	do	do	12	5,700	7	7	7	5	5	5	58.3	Cooking.
B	1	City or private	Glass bottle or demijohn	9	2,900	5	5	5	4	4	4	55.6	Drinking.
B	1	do	Galvanized-iron tank	7	5,000	0	0	0	1	1	1	0	Cooking.
C	1	River; boilers	Wooden barrel	1	80	0	0	0	1	1	1	0	Cooking, washing dishes.
C	1	City supplies	Galvanized-iron barrel	8	6,300	8	8	8	0	0	0	100	Drinking.
C	1	do	do	3	4,100	3	3	3	0	0	0	100	Cooking.
C	2	River; boilers	Wooden barrel	3	123	0	0	0	3	3	3	0	Washing dishes.
C	2	City supplies	Galvanized-iron barrel	8	6,700	6	6	6	2	2	2	75	Drinking.
C	2	do	do	3	10,300	2	2	2	1	1	1	66.7	Cooking.
C	3	do	do	15	4,700	4	4	4	11	11	11	26.7	Drinking.
C	3	do	do	13	6,200	3	3	3	10	10	10	23.1	Cooking.
D	1	River; boilers	Wooden barrel	2	40	0	0	0	2	2	2	0	Washing dishes.
D	1	City and private	Wooden tank	6	4,400	3	3	3	3	3	3	50	Drinking.
D	1	do	do	6	6,300	6	6	6	0	0	0	100	Cooking.
D	2	River; boilers	Wooden barrel	2	30	0	0	0	2	2	2	0	Washing dishes.
D	2	City and private	Wooden tank	8	3,000	1	1	1	7	7	7	12.5	Drinking.
D	2	do	do	5	2,000	0	0	0	5	5	5	0	Cooking.

[a] Fleet A: Drinking water drawn from general storage tank to 5-gallon glass demijohns. Ice and water not in contact in cooler.
Fleet B: Drinking water purchased in 5-gallon glass demijohns. Ice and water not in contact in cooler.
Fleet C: Drinking water drawn from general storage tank in pails for filling metal cooler. Ice and water in contact.
Fleet D: Drinking water cooler filled from storage barrels direct. Ice and water not in contact.

It will be noted that in practically all cases the bacteria counts on agar plates incubated at 37° C. are far in excess of the Treasury Department standard of 100 per cubic centimeter. The bacteria counts were frequently as high in samples which gave negative results in presumptive tests for the *B. coli* group as in those which gave positive results. Since the public and private supplies from which these vessels obtained their water were all certified as producing a water of satisfactory sanitary quality, one would not expect such high bacteria counts if the water was properly protected from the time it was drawn from the hydrants ashore until it was delivered to the crew or traveling public aboard, from the taps in the galley quarters or at the drinking-water coolers. As described above, excessive handling of this water under conditions existing in the steamboat traffic certainly exposes it to many potential sources of contamination, and, therefore, in order to protect the water obtained ashore for drinking and culinary purposes, it is imperative that a more direct and satisfactory method for delivering this water to and storing and distributing the same aboard vessels should be adopted. In the following paragraphs suggested methods for different classes of passenger vessels are described.

Inland River Vessels.

These vessels are of three classes: (1) Regular packet, freight, and passenger vessels operating on regular schedules between terminal river ports; (2) local excursion steamers operating out of a single port; and (3) miscellaneous craft, such as tows, barges, dredges, sand suckers, and others. Vessels of each of these classes stop at same landing or wharf boats each trip, and therefore arrangements could be made to locate hydrants for conveniently obtaining drinking water ashore. An exception to this statement would be vessels which frequently operate on rivers along which no cities are located for great distances, or vessels which remain away from port for weeks at a time. On such vessels, there should be installed a distiller of sufficient capacity to supply all water used for drinking and culinary purposes.

At one of the large Ohio River cities a line was extended from the city main to the public landing at the expense of one of the shipping companies. There has been some discussion among city waterworks officials and the shipowners as to who should pay for such a line. As there is a distinct public health value to the community in having all vessels calling at its port provided with a safe drinking-water supply, the municipality should at least be willing to make reasonable concessions in connection with the extension of such a pipe line. Indeed, the more progressive city, in accordance with its public health policies, might make this extension free of charge.

There is one feature common to river shipping which is different from that of lake or coastwise navigation, namely, the variation in the river level. On lakes the water level is fairly constant, and wharves and piers are built as "permanent" structures at a predetermined distance above high-water line. In tide-water ports, an elevation above high or mean tide is usually set for structures. But at river ports, if water shipping is to be uninterrupted, arrangements must be made to meet conditions developing as a result of varying levels of the river. Accordingly, the details in connection with the supplying of drinking water to these vessels must be adjusted to meet these conditions.

Obviously, a hydrant located at low-water level on the public landing or incline would be submerged during times of high water. Therefore, at river ports several connections to the water main at different hydrants could be set each in a valve box with a heavy cover fitting flush with the floor of the incline and provided with a seep drain (see Fig. 2). The spacing of these hydrants up the incline will in general depend on local conditions. It is believed that there should be at least one of these connections for every 15 feet vertical rise of the incline. Spacing at wider intervals will mean that long lengths of hose must lay on the landing. This hose, besides being inconvenient to trucking, will be liable to injury from the same.

Corresponding to the permanent piers and docks at lake and coastwise harbors are the river wharf boats, which serve as both piers and freight sheds. As the river rises or lowers, the position of the wharf boat is changed accordingly, and as a result the booms, gangplanks, and electric lines must be adjusted to accommodate this movement. So, also, it would be necessary to adjust the hose connection from the landing hydrants to the wharf boat, either by varying its length or by making a new hydrant connection. Between the wharf boat and the bank of the incline there is always a water space of several yards, depending upon the slope. Where public sewers discharge into the river at or above the wharf boats, the water around this vessel will be grossly contaminated, and every precaution must be taken to prevent the hose from dropping into it. If the water hose is attached to the wharf-boat connection and allowed to sag of its own weight between this point and the landing, it is very probable that when adjustments are made to this hose at the wharf-boat end, it will be dropped into the water. The contamination of the city water supplied to the storage tanks aboard the vessel with but a small quantity of this sewage-laden river water might result in the infection of a great many persons drinking water aboard. It is therefore desirable that the hose section between the wharf boat and the landing be laid on or in a guideboard or pipe conduit, either of which may be conveniently attached to the frame structure supporting the guide rail on the gangplank (see Fig. 3).

On the wharf boat, from the land-side connection, a galvanized-iron pipe system could be installed to deliver this water to the river side of the boat. The pipe should be carried across the boat by attaching it to the lower chord of a roof truss. On the river side, as many connections can be made as are needed for the convenience of supplying water to the vessels docking alongside the wharf boat. Such a piping system on the wharf boat has a distinct value as a fire-protection measure.

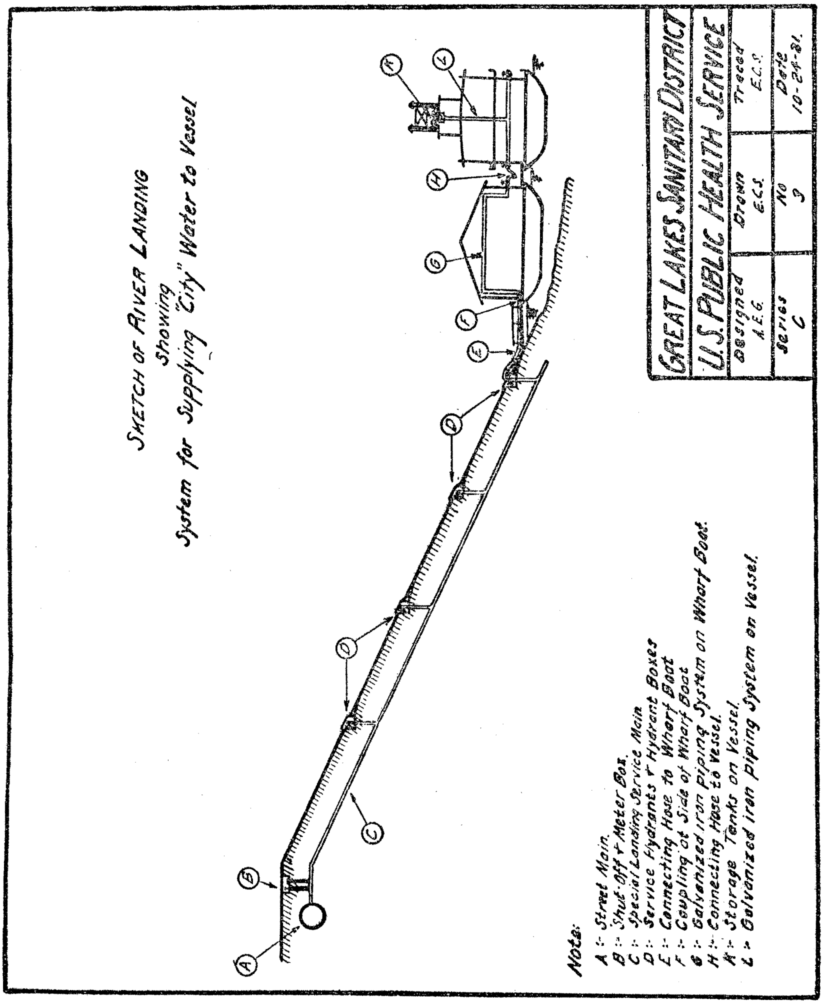
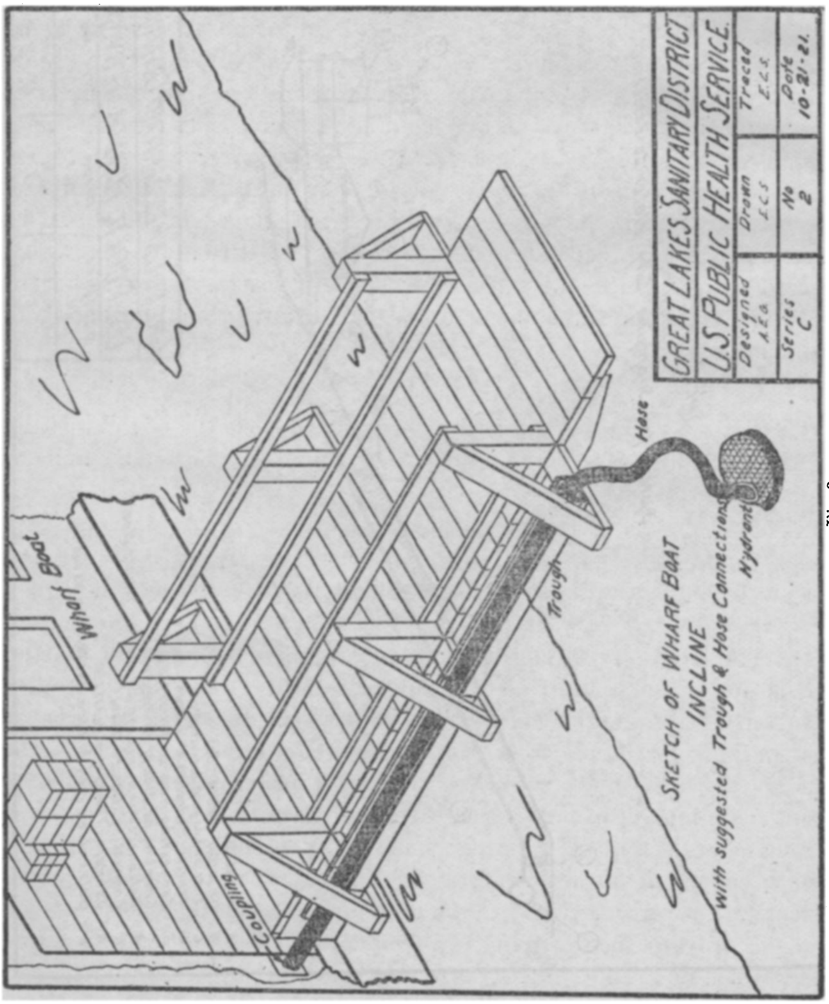

Sketch of River Landing
Showing
System for Supplying "City" Water to Vessel
A
B
C
D
D
D
E
F
G
H
K
L
Note:
A :- Street Main.
B :- Shut-Off & Meter Box.
C :- Special Landing Service Main
D :- Service Hydrants & Hydrant Boxes
E :- Connecting Hose to Wharf Boat
F :- Coupling at Side of Wharf Boat
G :- Galvanized iron piping System on Wharf Boat.
H :- Connecting Hose to Vessel.
K :- Storage Tanks on Vessel.
L :- Galvanized iron piping System on Vessel.
Great Lakes Sanitary District
U.S. Public Health Service
Designed A.E.G.
Drawn E.C.S.
Traced E.C.S.
Series C
No 3
Date 10-24-21.

Fig. 2.

It is very desirable that these connections be located as far above the floor of the wharf boat as will be convenient for making the hose attachment, in order to make as remote as possible the opportunities for contaminating the pipe ends. A valve at the river side of the wharf-boat piping should be provided, while one at the bank terminal would be convenient, although not necessary. For purposes of identification and to warn against the stacking of freight in front of these water connections on the wharf boat, they should be properly posted. A sign with background in color of distinct contrast to the general color of the wharf-boat shed will very well serve this purpose. If pumps are installed on the wharf boats for pumping river water for fire purposes, or if any other hydrants for water other


GREAT LAKES SANITARY DISTRICT
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Traced E.C.S.
Series C
No 2
Date 10-21-21.
Hose
Hydrant
Trough
Wharf Boat
Coupling
SKETCH OF WHARF BOAT INCLINE
With suggested Trough & Hose Connection

Fig. 3.

than drinking water are located on the landing, all outlets and hydrants in these water systems should be identified and posted, warning against the use of this water for drinking purposes. The painting of drinking-water hydrants and outlets white and all others red is a simple way to distinguish between the two, the colors being symbolic of purity and danger, respectively.

Between the wharf-boat connection and the vessel a second section of hose will be necessary. Each vessel should carry its own drinking water supply hose, which should be used for no other purposes. It should be so stored away on the ship as to protect it from possible contamination. The shorter this section of hose is the better, and, therefore, it is highly desirable that delivery pipes to the storage tanks be installed on the vessel, with connections on both sides of the ship, to which the hose connecting with the wharf boat can be attached. The direct filling of storage tanks through a long hose inserted into the tanks is unsatisfactory, as careless handling of the hose or leaving the tank cover open may result in contamination of the drinking water.

Coastwise Vessels.

There are two methods by which water to be used for drinking and culinary purposes and obtained from certified sources ashore may be supplied to this class of ships:

(1) Through hose direct from hydrants on the wharves or piers at which the vessel docks, or

(2) Through hose direct from water boats, whose tanks are filled through hose from hydrants on wharves or piers.

(1) The location of hydrants on docks is a very important matter, and is one which should be given careful study. If it is desired to locate a hydrant under the floor of the wharf, in order to have no obstructions on the platforms, care should be taken to see that the end of this hydrant is protected against contamination which may result from filth dropping through the platform floor or being washed through during rains or flushing of the floors of the piers. A "gooseneck" curve on the pipe forming this hydrant is usually satisfactory in preventing filth from collecting in the end of the pipe. In order to prevent the dropping of the end of the hose into the polluted waters of the harbor, either through accident or carelessness, it is desirable to set all hydrants back at least 2 feet from the edge of the pier. It is obvious that the hydrants should be self-draining and the supply pipes protected against freezing in winter.

Drinking-water hydrants should be so marked as to be readily distinguished from all other hydrants on a pier, as outlined under the section on river vessels.

The size and length of water hose will, of course, depend upon local conditions; but every effort should be made to reduce the length of hose in the interests of economy and convenience. To prevent injury to hose having threaded-end couplings, a metallic cap should be provided and screwed over the end when not in use. The cap should be fastened to the hose coupling by a chain to insure against losing it. Suitable storage should be provided, either on board the vessel or on the dock, for drinking-water hose, which should be easily identified so that it would not be used for any other purposes. Painting this hose white would be an inexpensive way of identifying it.

(2) For water boats, particular care should be given to the details mentioned above for protecting the water delivered to its tanks. The pump for delivering water from the water boat to the supply tanks on a vessel should be used for this purpose only and should be independent of all other water systems. In case water is transferred from the water boat to the supply tanks aboard a vessel, on the "siphon principle," special care should be taken in charging this siphon that only the drinking-water supply is used. Sterilization and flushing of storage tanks on water boats should be done weekly without fail.

The design and sanitation of water boats are very important public-health problems, if the delivery of water by this medium to other vessels for drinking and culinary purposes from certified sources ashore is to be free from the many potential dangers associated with it. The ideal type of water boat is one in which the storage tanks are of iron or steel, each tank having no openings or connections other than a bolted manhole, an intake pipe, a discharge pipe, and a connection for complete draining of the contents of the tank into the bilge. There are many water boats in which the tanks are constructed of plain cypress planks with tar-pitched joints. The deck of the vessel usually forms the top of such tanks; and unless extreme care is taken to maintain them in a tightly calked condition, there is grave danger of contamination of the water in the tanks by leakage from the deck through these unprotected seams. The hatches to such tanks should be of water-tight construction, kept locked at all times, and the edges should be protected by a leather or rubber gasket fitting closely to a raised flange.

For filling the tanks, a filling plug (provided with a cap) raised above the level of the boat's deck, to which the delivery hose from the dock may be connected, should be provided. The discharge pumps for delivering water from the water boat should be independent of all other water-supply systems or sources. It is essential that there should be no way by which any water other than that obtained from the certified source of supply ashore may be admitted to the storage tanks or delivered to another vessel for drinking and culinary purposes from the water boat. Care should be taken to prevent contamination of the hose used aboard this type of vessel. Threaded caps should be provided for the protection of the hose ends when not in use. The decks should be kept in a clean condition.

Weekly sterilization and thorough draining and flushing of the tanks should be part of the routine procedure. A satisfactory method of sterilization is to allow a solution of hypochlorite of lime in the proportion of 1 pound of the chemical to every 5,000 gallons of water to remain overnight in the tanks while completely filled. In the morning the tanks should be emptied and then flushed thoroughly.

Great Lakes Vessels.

The method of supplying water for drinking and culinary purposes from sources ashore to Great Lakes vessels is similar in every respect to that for coastwise vessels. The same precautions relative to location, protection, and identification of hydrants described above should be taken. Water boats are not common on the Great Lakes.

At Buffalo, Detroit, and Chicago city water was supplied to Great Lakes passenger vessels operating during the 1921 season with satisfactory results. The following table is a compilation of the results of bacteriological analyses of samples collected from the drinking systems on these vessels in the summer of 1921 and analyzed by the local city health departments:

TABLE II.

Fleet.	Vessel.	Source of supply.	Storage aboard.	Number of samples.	Average bacteria per c. c. 37° C., 24 hours.	B. coli determinations.						
						Positive.			Negative.			Per cent positive, 10 c. c.
						C. c.			C. c.			
						10	1	0.1	10	1	0.1	
A	1	Detroit	Iron tanks	37	145	6	5	1	31	32	36	16.2
B	1	do	do	8	225	0	0	0	8	8	8	0
C	1	do	do	21	180	0	0	0	21	21	21	0
C	2	do	do	2	250	0	0	0	2	2	2	0
C	3	do	do	7	200	0	0	0	7	7	7	0
D	1	Buffalo	do	48	330	13	4	0	35	44	48	27.1
D	2	do	do	41	410	12	7	0	29	34	41	29.3
E	1	Chicago	do	11	18	1	....	....	10	11	11	9.1

If one is to compare this table with the one (Table I) given for water supplies on Ohio River vessels he should bear in mind the point brought out by the sanitary experts reporting to the International Joint Commission in connection with their classification of Great Lakes water, given on pages 20 and 21 of the Progress Report of this commission dated January 16, 1914, from which the following is quoted:

"In considering this classification it is to be remembered that it is *arbitrary*. The classification arises out of the data contained in this report. The differences in bacterial flow of these lake waters and that of comparatively warm river waters, subject to agricultural and municipal drainage, is very great, especially when measured by bacterial counts on agar and *B. coli*, which represent almost invariably for these lake waters recently added sewage organisms."

By their classification, bacteria counts on agar which might be considered relatively low (under 100 per c. c.) in waters of some district could and probably would be associated with gross pollution of recent origin in the waters of the Great Lakes. The water supplies from Buffalo, Detroit, and Chicago are all obtained from the Great Lakes in areas subjected to pollution, the only treatment before delivery to the city mains being disinfection by chlorine. For this reason it is believed that the bacterial counts on agar reported in the above table are not of great sanitary significance where the determinations for *B. coli* were negative; for while stored in tanks aboard the vessels, especially if these tanks were in proximity to the engine rooms, "aftergrowths" of spore-forming bacteria of nonfecal origin might develop.

Tugs, Tender, Tows, Canal Barges, and Miscellaneous Craft.

The water supply for these smaller vessels, if obtained from sources ashore, should be delivered to and stored aboard the boat with the same care as that given to larger vessels. The gravity system with a storage tank or tanks on the cabin house is probably the most economical installation. The carrying of water aboard in pails and storing it in a keg or crock is very unsatisfactory from a sanitary standpoint for the reasons already outlined in this report. The practice of obtaining water for drinking and culinary purposes from overboard in a pail to which a rope is attached, which is so common on these small boats, is as primitive as it is vicious and insanitary. This practice is all the more dangerous on smaller craft, as they frequently navigate in harbors and relatively shallow waters near shore, which are usually grossly polluted by sewage. (See Fig. 4.)

Conclusions.

1. Where water to be supplied for drinking and culinary purposes on vessels is obtained from sources ashore which are certified as producing water of satisfactory sanitary quality and safety, such water may, through excessive handling in delivery to and storage aboard a vessel, be so contaminated as to render it entirely unfit and unsafe for human consumption.
2. The methods by which drinking water was delivered to passenger vessels operating on the Ohio and Mississippi Rivers during the

summer, 1921, involved such excessive handling of this water that it was frequently contaminated and thereby rendered unsafe for human consumption.

3. Water obtained from sources ashore, where the hydrants are located on or at the pier or wharves, can be delivered to these vessels through hose with a reasonable minimum exposure to contamination, if proper precautions are taken.

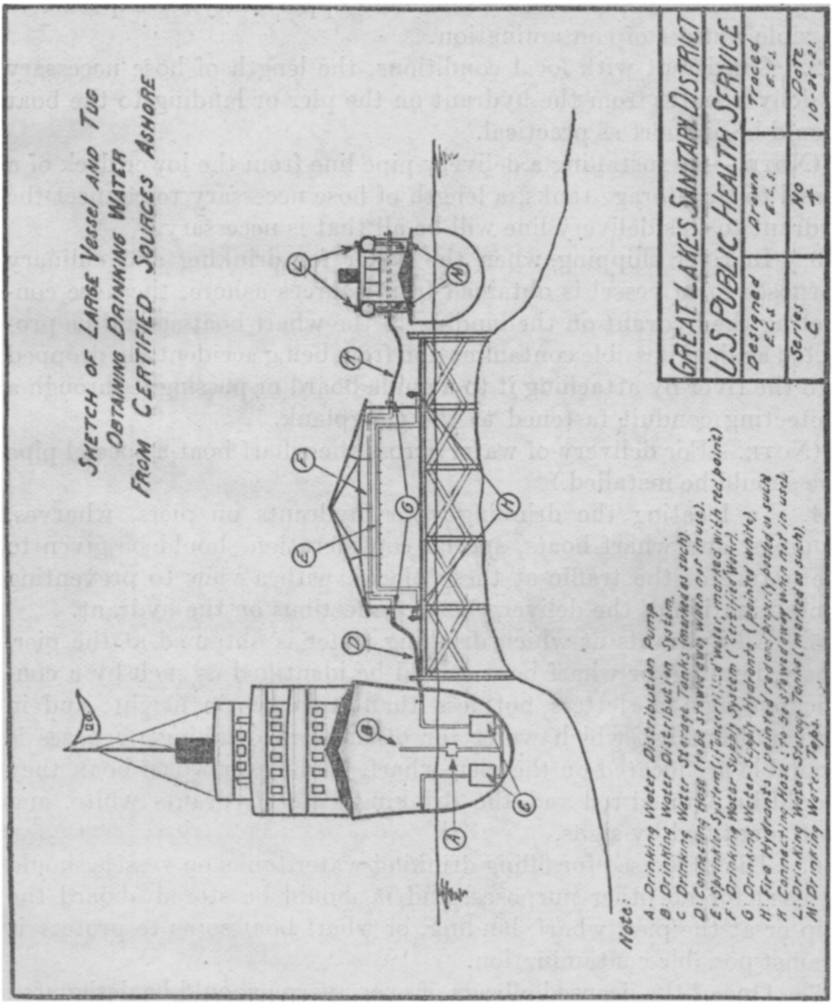
SKETCH OF LARGE VESSEL AND TUG
OBTAINING DRINKING WATER
FROM CERTIFIED SOURCES ASHORE
A
B
C
D
E
F
G
H
K
L
M
Note:
A: Drinking Water Distribution Pump
B: Drinking Water Distribution System.
C Drinking Water Storage Tanks (marked as such)
D: Connecting Hose (to be stowed away when not in use).
E: Sprinkler System (if uncertified water, marked with red paint)
F: Drinking Water Supply System ("Certified Water).
G: Drinking Water Supply Hydrants. (painted white).
H: Fire Hydrants (painted red and properly posted as such)
K Connecting Hose; to be stowed away when not in use.
L: Drinking Water Storage Tanks (marked as such).
M: Drinking Water Taps.
GREAT LAKES SANITARY DISTRICT
U.S. PUBLIC HEALTH SERVICE
Designed E.C.S.
Drawn E.C.S.
Traced E.C.S.
Series C
No 4
Date 10-26-21

Fig. 4.

4. The method by which drinking water is stored aboard and distributed throughout a vessel is fully as important in protecting this water against contamination as the means by which it is delivered to the vessel.

Recommendations.

1. Where water to be used for drinking and culinary purposes on vessels is obtained from certified sources ashore, hydrants from which this water is to be drawn should be located on the pier, dock, or landing so that this water can be conveniently delivered to the vessel through a hose or pipe, with a minimum opportunity for exposure to possible sources of contamination.

2. Consistent with local conditions, the length of hose necessary to deliver water from the hydrant on the pier or landing to the boat should be as short as practical.

(NOTE.—By installing a delivery pipe line from the lower deck of a vessel to the storage tanks, a length of hose necessary to connect the hydrant to this delivery line will be all that is necessary.)

3. In river shipping, when the water for drinking and culinary purposes for a vessel is obtained from sources ashore, the hose connecting the hydrant on the landing to the wharf boat should be protected against possible contamination from being accidentally dropped into the river by attaching it to a guide board or passing it through a protecting conduit fastened to the gangplank.

(NOTE.—For delivery of water across the wharf boat a special pipe line should be installed.)

4. In locating the drinking-water hydrants on piers, wharves, landings, and wharf boats, special consideration should be given to the nature of the traffic at these places, with a view to preventing contamination of the delivery hose connections on the hydrant.

5. All hydrants at which drinking water is obtained at the pier, wharf, landing, or wharf boat should be identified as such by a conspicuous sign of letters not less than 4 inches in height; and in case hydrants at which water for other than drinking purposes is available are located on the pier, wharf, landing, or wharf boat, they should be painted red and the drinking-water hydrants white, and both identified by signs.

6. The hose used for filling drinking-water tanks on vessels should be used for no other purposes, and it should be stored aboard the ship or at the pier, wharf, landing, or wharf boat so as to protect it against possible contamination.

7. One of the licensed officers of every vessel should be designated as "water-supply officer" and held responsible for the drinking water provided on the vessel.